***Competency 1.5*** **Industrial hygiene personnel shall demonstrate a working level knowledge of data collection plans used to collect environmental data which accurately reflects exposure conditions.**

## 1. Supporting Knowledge and Skills

a. Discuss how the following factors may affect the sampling strategy:
- Representativeness of operations during sampling
- Environmental control methods in use
- Sample handling
- Data recording and management
- Chain of custody
- Statistical significance
- Exposure criteria and limits

b. Discuss how the following elements are used when developing a sampling strategy:
- Investigative design
- Duration
- Time requirements
- Need and procedures for bulk samples
- Routes of entry of harmful substances
- Job responsibility
- Number and composition of work force
- Number and type of operations and work schedules
- Plant layout

c. Describe how the safety of personnel conducting sampling and those being sampled is incorporated into the sampling plan or strategy.

d. Discuss privacy as it relates to record keeping and removal of records.

e. Discuss informed consent as it relates to taking samples (biological, etc.).

f. Discuss how the at-risk population affects the sampling strategy.

g. Describe how bioassay results are used by industrial hygiene personnel to evaluate exposures.

## 2. Recommended Reading

**Review**

- Patty's *Industrial Hygiene and Toxicology*, 4th Edition, Volume I, Chapter 27, "Industrial Hygiene Sampling and Analysis," and Volume IIIA, 2nd Edition, Chapter 8, "Statistical Design and Data Analysis Requirements," Clayton & Clayton.
- OSHA *Technical Manual*, 2nd Edition, Chapter 1, "Personal Sampling for Air Contaminants," and Chapter 2, "Sampling for Surface Contamination."
- NIOSH *Occupational Exposure Sampling Strategy Manual*. Occupational Exposure Sampling Strategy Manual, NIOSH Pub. No. 77-173.
- AIHA, *A Strategy for Exposure Assessment*.

## 3. Summary

In general, the group of employees that works in the closest proximity to the agent, for the longest duration, with the fewest controls, and that consumes the largest quantities of the agent (i.e., welder, painter, abrasive blaster) will have the greatest potential for significant exposure. These groups should be sampled first because if they are not significantly exposed, other groups are unlikely to be. In situations where significant exposure is suspected in a workforce, but where the higher risk groups cannot be identified (i.e., due to noise in factory population), random sampling throughout the workforce may be required.

Sampling should be performed on operations that are representative of typical and of worst-case situations of the exposure group. Depending on the sampling results, the former may help to determine the need for employee medical surveillance and latter the need for the implementation of workplace controls.

Operations variables observed during sampling such as work and environmental conditions and control methods in use should be noted in order to ensure the subsequent value of sampling data as a useful predictor of future employee exposure in similar operations.

There is little reason to sample unless the results are related to established or future occupational exposure limits. The occupational exposure limit is also critical in determining the volume of air that must be sampled in order to ensure that the detection level of the sample is less than the occupational exposure limit.

Routine bioassays and similar medical surveillance, such as the measurement of employee blood lead levels, provide "defense in depth" to industrial hygiene field surveillance. These measurements are also useful in assessing the overall success of the exposure control program and of the use of personal protective equipment. Bioassays may be performed in response to single extremely elevated exposure episodes. Bioassays may also be useful in characterizing exposure when monitoring was not possible, i.e., when exposure occurred through ingestion or absorption.

Because of their general lack of close proximity to hazardous operations, industrial hygienists and technicians usually do not receive significant exposure. Therefore, precautions directed toward controlling exposure to sampling personnel usually are not needed. Exceptions to this general guide apply, e.g., for personnel sampling within an asbestos containment. Despite the lack of potential for significant exposure, the performance of occasional monitoring on industrial hygiene personnel is useful in documenting this fact, not only for the historical record, but also for use in making analogies with other employee groups working "on the edge" of real exposure situations.

Sampling should be performed in accordance with established Standard Operating Practices (SOP's) in order to ensure that the observations are recorded consistently and sampling plans are coordinated with the laboratory in order to guarantee compatibility between sampling and analysis.

Sampling sheet completion should be standardized and the completion reviewed by at least one level of supervision. Samples should be tracked in a log along with critical sampling information in order to have a hard-copy index of the sampling history of the facility. Critical sampling data should be entered into a database for easy retrieval and sorting of data.

Bulk sampling may be useful before or in conjunction with personal sampling. Bulk sampling may be necessary before personal sampling in order to identify constituents not listed on an Material Safety Data Sheet (MSDS), or when an MSDS is not available. Bulk sampling may also be useful in identifying exact percentages of agents in the sample. This variable may be of importance in predicting future exposure levels during similar activities.

For some substances, air monitoring alone may not be adequate. For substances that readily pass through the skin, i.e., organophosphates, and for which skin contact is likely, significant exposure via this route should be assumed. Wherever housekeeping and personal sanitation are poor, significant exposure via ingestion may also be possible.

Chain of custody is critical with respect to the confidence of the integrity of the data. As a consequence, practices must be established to ensure the sealing and labeling of samples, the tracking of samples through the completion of analysis, and the forwarding of the analysis results to the sampling organization.

Statistical significance of sampling results may be obtained in two ways. The first relates to the analysis of individual samples through the determination of the upper and lower confidence limits of that sample. This is done in order to determine if the individual sample is above or below the occupational exposure level. The second aspect of statistical significance relates to the analysis of a group of past samples in order to determine the potential for overexposure in future samples. Statistical significance of this type is highly desirable and should be sought for operations that are performed regularly. For infrequently performed operations, the number of data points will probably be too small to achieve this type of statistical significance.

## 4. Suggested Exercises

Please refer to Scenarios 5 and 6 in the Scenario section of this document.